

**UNITED STATES DISTRICT COURT  
DISTRICT OF MASSACHUSETTS**

SINGULAR COMPUTING LLC,

Plaintiff,

v.

GOOGLE LLC,

Defendant.

Civil Action No. 1:19-cv-12551-FDS

Hon. F. Dennis Saylor IV

**REDACTED VERSION**

ORAL ARGUMENT REQUESTED

**PLAINTIFF'S OPPOSITION TO GOOGLE'S MOTION FOR  
SUMMARY JUDGMENT OF NON-INFRINGEMENT**

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**TABLE OF CONTENTS**

I. INTRODUCTION ..... 1

II. LEGAL STANDARD..... 1

III. ARGUMENT ..... 2

    A. Google’s assertion that the accused TPUv2/v3 devices have “at most” 1,024 / 2,048 LPHDR execution units is incorrect ..... 2

        1. Dr. Khatri demonstrates that the accused TPUv2 and TPUv3 devices contain [REDACTED] LPHDR execution units, respectively..... 2

        2. Google’s arguments are inconsistent with the specification of the patents-in-suit, and are refuted by Google’s own invalidity experts ..... 8

    B. Dr. Khatri does not count LPHDR [REDACTED] LPHDR execution units, as Google alleges, nor does Dr. Khatri opine that it would be “proper” to do so..... 10

    C. Google attempts to justify its arguments by mischaracterizing the language of the Asserted Claims ..... 12

IV. CONCLUSION..... 14

**TABLE OF AUTHORITIES**

**Cases**

*Anderson v. Liberty Lobby, Inc.*,  
477 U.S. 242 (1986)..... 1, 2

*Celotex Corp. v. Catrett*,  
477 U.S. 317 (1986)..... 1

*INVT SPE LLC v. Inter. Trade Comm’n*,  
46 F.4th 1361 (Fed. Cir. 2022) ..... 11

*Kara Tech. Inc. v. Stamps.com Inc.*,  
582 F.3d 1341 (Fed. Cir. 2009)..... 9

*Matsushita Elec. Indus. Co. v. Zenith Radio Corp.*,  
475 U.S. 574 ..... 1

Plaintiff, Singular Computing LLC (“Singular”), respectfully submits this Memorandum of Law in Opposition to the Motion of defendant, Google LLC (“Google”) for Summary Judgment of Non-Infringement.

## **I. INTRODUCTION**

Google’s motion for summary judgment of non-infringement ultimately rests on a single, conclusory non-infringement argument that Google cannot justify, and does not even bother to explain. Google uses the remainder of its motion to attack Singular’s expert, Dr. Sunil Khatri, dismissing his infringement arguments as “workarounds” that are “legally flawed” and “impermissible.”

As explained in detail below, Google’s positions are based on incorrect factual assumptions about the underlying technology, strawman arguments, misleading statements about the claim language, and a consistent refusal to acknowledge inconvenient evidence. Google’s arguments raise numerous material questions of fact that preclude summary judgment. Accordingly, Singular asks the Court to deny Google’s motion.

## **II. LEGAL STANDARD**

Summary judgment is appropriate when, after reviewing the record, as a whole, the court determines that no genuine issue of material fact exists, and the moving party is entitled to judgment as a matter of law. Fed. R. Civ. P. 56(a); *Anderson v. Liberty Lobby, Inc.*, 477 U.S. 242, 247-48 (1986). The party seeking summary judgment must initially demonstrate the absence of a genuine issue of material fact or the absence of evidence to support the nonmoving party’s case. *Celotex Corp. v. Catrett*, 477 U.S. 317, 325 (1986).

When deciding a motion for summary judgment, “the inferences to be drawn from the underlying facts ... must be viewed in the light most favorable to the party opposing the motion.” *See Matsushita Elec. Indus. Co. v. Zenith Radio Corp.*, 475 U.S. 574, 587. A court should not grant

a motion for summary judgment unless the record shows that a reasonable jury could not find for the nonmoving party. *Anderson*, 477 U.S. at 248.

### III. ARGUMENT

#### A. Google's assertion that the accused TPUv2/v3 devices have "at most" 1,024 / 2,048 LPHDR execution units is incorrect

In order to meet the "exceeds by at least one hundred" requirement of the Asserted Claims, an accused TPU device needs to include at least 8,300 LPHDR execution units. *See* Khatri Dec., Ex. 1 ¶ 235<sup>1</sup>; *see also* Google Br. at 1. Google argues that this requirement is not met because "there could only be, at most, 1,024 and 2,048 such LPHDR execution units in the accused version 2 and version 3 TPU boards, respectively." Google Br. at 1.

As explained below, this factual assertion is explicitly refuted by Dr. Khatri, contradicts the plain language of the patent specification, and is inconsistent with the testimony of Google's own expert witnesses. Because Google's non-infringement position rests entirely on this disputed issue of fact, the Court should deny Google's request for summary judgment of non-infringement.

##### 1. *Dr. Khatri demonstrates that the accused TPUv2 and TPUv3 devices contain [REDACTED] LPHDR execution units, respectively*

In its brief, Google characterizes the false assertion that the accused TPUv2/v3 devices contain [REDACTED] LPHDR execution units as a "simple mathematical fact" that Dr. Khatri "does not (and cannot) contest." Google Br. at 1.

Not so. Dr. Khatri *can* and *does* contest Google's flawed premise. In his report, Dr. Khatri explains that a TPUv2 device has [REDACTED] Matrix Multiply Units ("MXUs") and that a TPUv3 device has

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<sup>1</sup> A copy of Dr. Khatri's full report, including his curriculum vitae, is attached as Exhibit 1 to the accompanying Declaration of Dr. Sunil Khatri in Support of Plaintiff's Opposition to the Motion of Defendant for Summary Judgment of Non-Infringement ("Khatri Decl.").

██████ MXUs. His report also demonstrates that each “MXU” corresponds<sup>2</sup> to ██████ LPHDR physical execution units. *See* Khatri Dec., Ex. 1 ¶¶ 224-227. Using the number of LPHDR execution units per MXU and the number of MXUs per TPU device, he concludes that the TPUV2 device includes ██████ LPHDR execution units, and that the TPUV3 device includes ██████ LPHDR execution units. *Id.*

In his report, Dr. Khatri identifies the specific physical hardware in the Accused Devices included in each of the “LPHDR execution units”:

Khatri Dec., Ex. 1 ¶140. In particular, Dr. Khatri explains how each LPHDR execution unit includes a [REDACTED]

See *id.*; see also *id.* ¶¶ 128-145.

Dr. Khatri further explains that, for each MXU in the Accused Devices, there are

<sup>2</sup> Each LPHDR execution unit includes a group of interconnected components, some of which are located [REDACTED]

[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]  
[REDACTED]

*Id.* ¶¶ 231-232 (internal citations omitted). As the above passage explains, each of the [REDACTED]

[REDACTED]

As a matter of [REDACTED]

[REDACTED] *See id.* ¶¶ 228-232.

In this way, Dr. Khatri identifies [REDACTED] unique, physical LPHDR execution units per MXU, each of which includes a [REDACTED]

[REDACTED] *See id.* As discussed in more detail in §III.B, *infra*, Dr. Khatri explains how this conclusion is confirmed by the fact that all of these [REDACTED] LPHDR execution units [REDACTED] and are able to produce [REDACTED]

[REDACTED] *See id.* ¶ 228.

Google does not dispute Dr. Khatri’s understanding of the Accused Products and how they operate (as described in the paragraphs of his report cited above). Indeed, Dr. Khatri’s understanding of the TPU devices is corroborated by Google’s own expert, Dr. Walker. While Dr. Walker disagrees with Dr. Khatri about how to count the LPHDR execution units within the accused TPU devices, he does not dispute Dr. Khatri’s explanation of how [REDACTED]

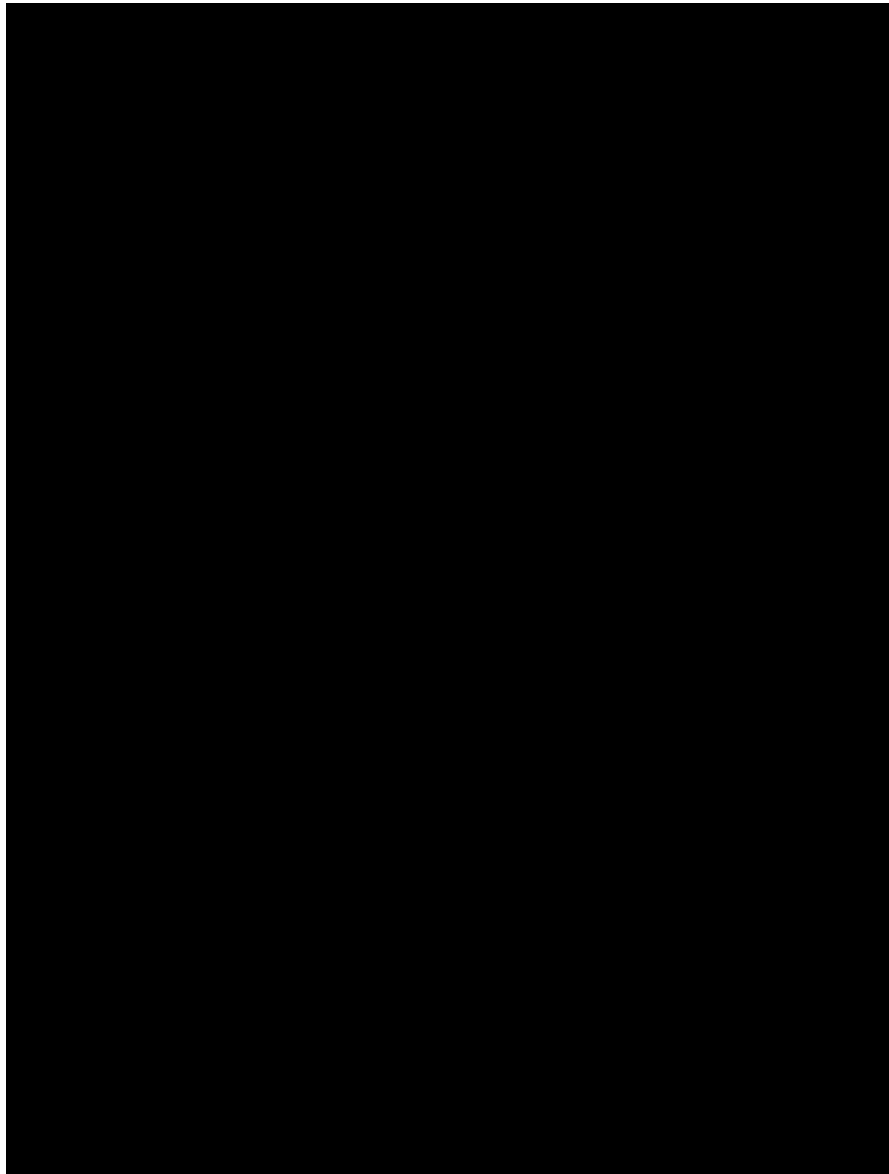
[REDACTED]

[REDACTED] *See* Declaration of Brian Seeve in Support of Plaintiff’s Opposition to the Motion of Defendant for Summary Judgment of Non-Infringement (“Seeve Decl.”), Ex. A (Walker Rpt.) ¶ 189.

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<sup>3</sup> In his report, Dr. Khatri refers to [REDACTED]  
[REDACTED] *See id.* ¶¶ 158-159.

The below diagram, excerpted from Dr. Walker's report, uses color-coding to illustrate his understanding of the relationship between [REDACTED]



*Id.* ¶189.<sup>4</sup> As Dr. Walker explains, [REDACTED]

[REDACTED]

[REDACTED] *See id.* ¶189. In particular, [REDACTED]

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<sup>4</sup> For simplicity, Dr. Walker's figure only shows [REDACTED]  
[REDACTED] *See id.* ¶189.



[REDACTED]

[REDACTED] *See id.*

[REDACTED]

[REDACTED] [REDACTED] *See id.* [REDACTED]

[REDACTED]

[REDACTED] *See id.*

The color-coding scheme in Dr. Walker's own diagram above demonstrates that [REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

[REDACTED]

Dr. Walker's and Dr. Khatri's opinions diverge when it comes to the [REDACTED]

[REDACTED] shown in the diagram above. Dr. Walker believes that there are only [REDACTED]

[REDACTED] based on his unsupported opinion that [REDACTED]

[REDACTED] *See* Seeve Decl., Ex. A (Walker Rpt.) ¶189.

Under Dr. Khatri's infringement theory, however, the diagram above shows [REDACTED]

[REDACTED]

[REDACTED] As explained above, Dr. Khatri opines that [REDACTED]

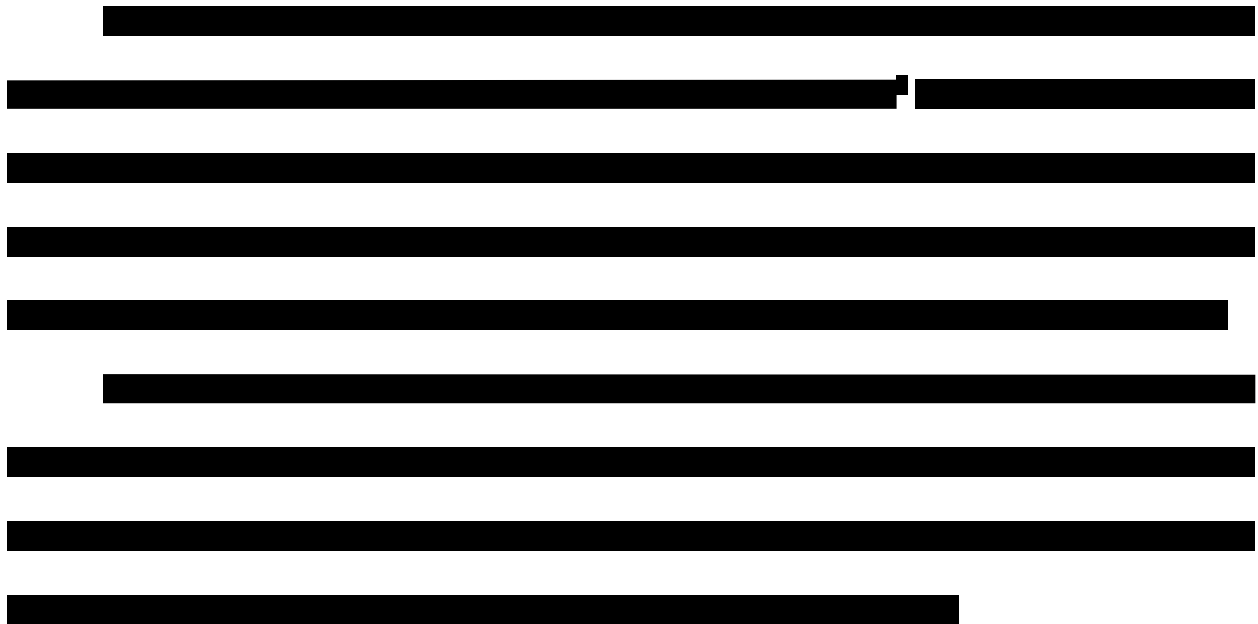
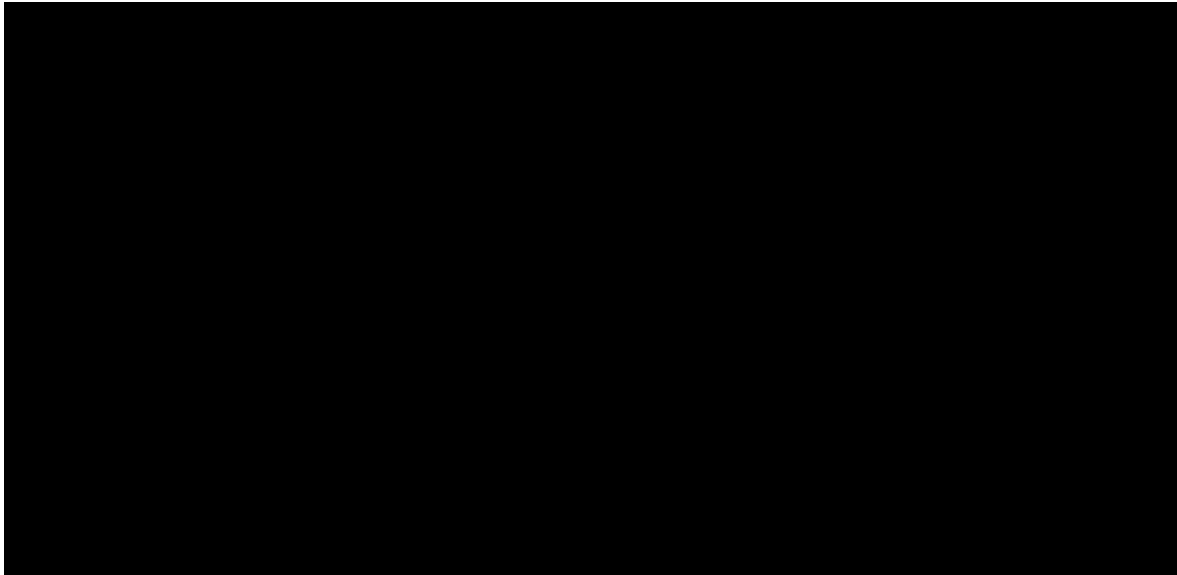
[REDACTED] *See* Khatri

Decl., Ex. 1 ¶140.<sup>5</sup> For example, the components corresponding to [REDACTED]

[REDACTED]

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<sup>5</sup> As Dr. Khatri explains, the LPHDR execution units of the Accused TPU devices also include at [REDACTED]



The diagram above is simplified for clarity. *See* Seeve Decl., Ex. A (Walker Rpt.) ¶189.

For each MXU in the actual accused products, there are

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(shown above using color-coded arrows). *See id.* ¶¶141-142.

<sup>6</sup> In the notation used here,

*See* Seeve Decl., Ex. B (Walker Tr.) at 109:16-110:4  
*also id.* at 111:1-4

[REDACTED] each of which is associated with [REDACTED]  
[REDACTED] which is consistent with Dr. Khatri's conclusion that there are [REDACTED]

**2. Google's arguments are inconsistent with the specification of the patents-in-suit, and are refuted by Google's own invalidity experts**

Google cites no evidence of any kind to support its position that “the accused TPUv2/v3 devices contain 1,024/2,048 LPHDR execution units.” Instead, Google merely asserts that, because there are [REDACTED]

While Google does not explicitly cite Dr. Walker's testimony (or anything else) to support this conclusion, it is nevertheless consistent with Dr. Walker's apparent belief that [REDACTED] [REDACTED] See Seeve Decl., Ex. B (Walker Tr.) at 107:20-24 [REDACTED]

There – (emphasis added).

Dr. Walker did not provide any justification for this factual statement at his deposition, merely stating that it is true of all “real circuits.” *See id.* at 106:12 [REDACTED]  
[REDACTED] *see also id.* at 106:24-107:1 [REDACTED]  
[REDACTED] Dr. Walker’s report, by contrast, explains that LPHDR execution units [REDACTED]

Decl., Ex. A (Walker Rpt.) ¶¶ 222-223.

It is improper to limit the claims based on a preferred embodiment, as Dr. Walker does. *See, e.g., Kara Tech. Inc. v. Stamps.com Inc.*, 582 F.3d 1341, 1348 (Fed. Cir. 2009) (“The patentee is entitled to the full scope of his claims, and we will not limit him to his preferred embodiment or import a limitation from the specification into the claims.”). Indeed, Dr. Walker’s assertion that LPHDR execution units [REDACTED] is *inconsistent* with the explicit teachings of the specification. *See, e.g.,* Seeve Decl., Ex. C (’156 Patent), 13:42-60 (explaining that in some embodiments, LPHDR execution units [REDACTED] for the sake of efficiency).

Furthermore, Google’s position is belied by the testimony of its own invalidity expert, Dr. Miriam Leeser. At her deposition, understanding that each LPHDR execution unit comprises an arithmetic circuit and a memory unit, Dr. Leeser testified that a prior art system called “VFLOAT” had 61 distinct “multipliers” that share a single SRAM “memory circuit.” Seeve Decl., Ex. D (Leeser Tr.) at 150:16-22; *see id.* at 151:22-152:7. She then concluded that this one SRAM circuit, together with 61 multipliers, constitute 61 distinct “LPHDR execution units,” each including a multiplier and a memory circuit (*i.e.*, the SRAM circuit).

Evidently, when it comes to validity, Google takes the view that “execution units” *can* [REDACTED] as shown by Dr. Leeser’s argument that a single SRAM circuit can be part of 61 distinct LPHDR execution units. Under Dr. Leeser’s reasoning, [REDACTED] (as described in §III.A.1, *supra*) [REDACTED]

“LPHDR execution units.” The fact that some [REDACTED]

<sup>7</sup>

When it comes to infringement, however, Google takes the view that two “execution units” *cannot* share any common circuitry. Google’s selective application of this principle demonstrates that it is not a principle at all, but rather a self-serving fiction invented by Google as a means to avoid liability.

**B. Dr. Khatri does not count LPHDR [REDACTED] LPHDR execution units, as Google alleges, nor does Dr. Khatri opine that it would be “proper” to do so**

Google ignores Dr. Khatri’s *actual* infringement positions relating to the “exceeds by at least one hundred” limitation (as described in §III.A.1, *supra*). Instead, Google falsely alleges that Dr. Khatri counts [REDACTED] LPHDR execution units. *See* Dkt. 462 (Google’s Statement of Undisputed Material Facts) at ¶35; *see also id.* at ¶¶32-33. Google then devotes the remainder of its brief to this strawman argument, dismissing it as a “workaround” that is “legally flawed” because it “impermissibly” treats the Asserted Claims, which are directed to devices, as method claims. *Id.* at 2, 13.

As described in §III.A.1, *supra*, Dr. Khatri clearly and unambiguously identifies the specific, physical circuitry in the accused TPU devices that corresponds to the claimed LPHDR execution units. *See* Khatri Decl., Ex. 1 ¶ 140. He further explains how [REDACTED]

LPHDR execution units per MXU. *See id.* ¶¶ 228-232.

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<sup>7</sup> Dr. John Gustafson, another of Google’s invalidity experts in this case, echoed Dr. Leeser’s opinion that multiple execution units [REDACTED] *See* Seeve Decl., Ex. E (Gustafson Rpt.) ¶ 256.

Google ignores Dr. Khatri's detailed description of the physical structure of the accused devices, and instead focuses solely on Dr. Khatri's statements about the number of LPHDR [REDACTED]<sup>8</sup> According to Google, the number of LPHDR [REDACTED] is wholly irrelevant to the question of infringement because it relates to "what the TPU allegedly does rather than what it is." Google Br. at 13.

Google is mistaken in its belief that evidence about the operation of the TPU devices is categorically irrelevant. On the contrary, "what [an accused] device *does* (and how it does it) is highly relevant to understanding what the device *is*, in the computer/software context." *INVT SPE LLC v. Inter. Trade Comm'n*, 46 F.4th 1361, 1377 (Fed. Cir. 2022) (emphasis in original).

Dr Khatri explains how the number of LPHDR [REDACTED] that can be completed by the accused devices in a [REDACTED] is evidence that *confirms* his description of the physical circuits comprising each of the [REDACTED] LPHDR execution units. The relationship between the number of [REDACTED]

[REDACTED] Dr. Khatri identifies as an LPHDR execution unit can only produce [REDACTED]

[REDACTED] See, e.g., Khatri Decl., Ex. 1 ¶ 140. Therefore, the fact that each MXU produces [REDACTED]

[REDACTED] LPHDR execution units per MXU.

The relationship between the number of LPHDR operations per cycle and the number of physical LPHDR execution units in the accused devices [REDACTED]

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<sup>8</sup> As Dr. Khatri explains in his report, a "clock cycle" is the period between two consecutive ticks of a computer's internal clock signal. See *id.* ¶ 62 (FN2). From the perspective of a computer, two events that occur in the same clock cycle occur simultaneously.

For example, in an email from

Seeve Decl., Ex. F.

There is no dispute that LPHDR execution units are distinct from the they perform. However, by counting the number of a device can perform per cycle, Dr. Khatri is able to establish a lower bound on the number of LPHDR execution units in the device.<sup>9</sup> Thus, Google’s assertion that Dr. Khatri conflates with LPHDR execution units is incorrect, and represents a genuine dispute of material fact.

**C. Google attempts to justify its arguments by mischaracterizing the language of the Asserted Claims**

In its effort to paint Dr. Khatri’s opinions about as irrelevant and improper, Google argues that the Asserted Claims do not define the claimed LPHDR execution units “in terms of functionality or capability,” and denies that the claim imposes any limitations relating to the “operations” that must be performed by the claimed LPHDR execution units. Google Br. at 2.

This characterization of the Asserted Claims effectively ignores the majority of the claim language:

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<sup>9</sup> Note that the number of execution units. In its brief, Google argues that this somehow makes Dr. Khatri’s argument “impermissible.” Google Br. at 17. But Google’s hypothetical example is consistent with the principle that the number of establishes a minimum number of LPHDR execution units in a device. The device might have more LPHDR execution units, but it cannot have *fewer*.

A device comprising:

at least one first **low precision high-dynamic range (LPHDR)** execution unit **adapted to execute a first operation on a first input signal representing a first numerical value to produce a first output signal representing a second numerical value,**

**wherein the dynamic range of the possible valid inputs to the first operation is at least as wide as from 1/1,000,000 through 1,000,000 and for at least X=5% of the possible valid inputs to the first operation, the statistical mean, over repeated execution of the first operation on each specific input from the at least X% of the possible valid inputs to the first operation, of the numerical values represented by the first output signal of the LPHDR unit executing the first operation on that input differs by at least Y=0.05% from the result of an exact mathematical calculation of the first operation on the numerical values of that same input;**

wherein the number of **LPHDR** execution units in the device exceeds by at least one hundred the non-negative integer number of execution units in the device adapted to execute at least the operation of multiplication on floating point numbers that are at least 32 bits wide.

Seeve Decl., Ex. G ('273 Patent) at Claim 53 (emphasis added).

In arguing that the claimed “low precision high-dynamic range (LPHDR) execution unit” is a purely “structural limitation,” Google pretends that the claim language in **boldface** above does not exist. Google Br. at 8 (“One key structural limitation in the Asserted Claims is the requirement of “at least one ... (LPHDR) execution unit”).

However, the Asserted Claims are *not* purely structural, and instead include a combination of structural and functional limitations. In particular, while the claimed “LPHDR execution unit” is a physical circuit, it must also be “adapted to execute a first operation” and “produce a first output signal.” Indeed, the term “LPHDR” – which the Court has properly construed to refer to the numerical percentages and ranges that are “defined in the claim itself” – is itself a functional requirement. *See* Dkt. 354, p. 30. Thus, Dr. Khatri’s opinion that the [REDACTED] “LPHDR multiplication operations” that result in [REDACTED] are in the



accused TPU devices is not just relevant; it is a *necessary* part of a complete infringement analysis.<sup>10</sup>

#### IV. CONCLUSION

Google's motion is based on illogical and self-serving arguments, inaccurate characterizations of Dr. Khatri's arguments, and conclusory statements about the operation of the accused products that are inconsistent with all available evidence. In view of these genuine disputes of material fact, Singular asks the Court to deny Google's motion for summary judgment of non-infringement.

#### **REQUEST FOR ORAL ARGUMENT**

Pursuant to Local Rule 7.1(d), Singular requests the Court to entertain oral argument on this motion, as Singular believes such will assist the Court in resolving the motion.

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<sup>10</sup> It is telling that Google explicitly reserves the right to argue that the Asserted Claims are *not* infringed using functional arguments. *See* Google Br. FN13 ("To be clear, Google does not concede that the ... purported "operation" that Dr. Khatri identifies is a "first operation" within the meaning of the claims ..."). Like Google's self-serving argument that two circuits cannot overlap (*see* III.A.2, *supra*), the argument that the Asserted Claims are purely structural appears to apply only when convenient.

Dated: May 19, 2023

Respectfully submitted,

/s/ Kevin Gannon

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**CERTIFICATE OF SERVICE**

I certify that all counsel of record who have consented to electronic service are being served with a copy of this document via the Court's CM/ECF system.

/s/ Kevin Gannon